



NEW LEARNING OF GEOGRAPHY WITH TECHNOLOGY: THE TPACK MODEL

Isabel María GÓMEZ TRIGUEROS

University of Alicante, Department of General and Specific Didactics, Alicante, Spain

isabel.gomez@ua.es

Abstract

The increasing importance of technologies in the different aspects of life has led to the development of teaching and learning models such as the Technological Pedagogical Content Knowledge model that allows integrating technology, pedagogy and disciplinary knowledge. The main objective of this work is to evaluate the formative possibilities of this model for 240 students of the subject of "Didactics of Social Sciences: Geography of Primary Degree of the Faculty of Education of the University of Alicante, to elaborate didactic proposals of Geography with technology. The methodology implemented has been active and cooperative. The study is a mixed one, combining quantitative and qualitative analyzes based on two instruments: the questionnaire and the materials produced by the participants. The results show the acquisition of geographical knowledge, of digital competence and of active methodologies.

Keywords: *TPACK, Geography, ICT, BPL, initial training teacher's*

1. INTRODUCTION

TPACK refers to the acronym for "Technological Pedagogical Content Knowledge" (TPCK or TPACK). It is a model of teaching and learning (T-L) that identifies the types of knowledge that a teacher needs to master in order to integrate Information and Communication Technologies (ICT) in an effective way in the teaching that he imparts. It is included among cognitive models in cooperative environments where, in addition, technology is used.

Pioneers in the implementation of this model are Professors Punya Mishra and Matew J. Koehler of Michigan State University (between 2006 and 2009). For these researchers there are three elements that intervene in the acquisition of knowledge: Content Knowledge (CK) or knowledge about the content of the specific subject to be taught; Pedagogical Knowledge (PK) or knowledge of the pedagogy necessary for the students to reach those contents; Technology Knowledge (TK) or knowledge of the technology involved in the learning process.

Based on these three basic components, different combinations are carried out in a way that builds a framework of interrelations that every teacher must know and use for a correct integration of ICT in their daily activity (Mishra and Koehler, 2006).

This paper analyzes the existing bibliography on this model of T-L as well as the possibilities offered in the initial training of primary school teachers, specifically for its implementation in the area of Didactics of Geography. We present a proposal for real intervention and the first evaluation results of the project carried out in the Faculty of

Education of the University of Alicante, during the academic years 2016-2017, with students of 2nd year.

2. BACKGROUND OF TPACK MODEL

Traditionally, teacher training is limited to the acquisition of knowledge about one or several disciplines, depending on whether they are professionals for Primary, Secondary or Higher education, with pedagogical training being in second level.

In the studies of Primary School Teachers of the Spanish universities, there are specific subjects, in which only the pedagogical training is worked, albeit from a theoretical and impractical point of view (Arquero and Donoso 2004).

The studies responsible for the analysis of the development of educational research show a consensus in reference to the idea that there is still the pending task of deepening in the pedagogical research and in the changes that occur in the classroom. Abraham and Rojas (1997) leave latent the permanence of traditional forms in pedagogical practices regardless of the educational levels to which it refers, with the little work of action on the training and improvement of future teachers. The consequence of this situation is observed into teachers who teach theoretical classes, in the style of master class, repeating the models they have learned throughout their university education.

Against this background, more usual than it may seem, a series of active and collaborative T-L methodologies have been proposed, adapted to the current world in constant evolution. And it is clear that in order to train resolving and prepared professionals, it is also necessary that the educational model be flexible and adapts to new demands and situations. Among such methodologies are Collaborative Learning Techniques (TACs), Project Based Learning (PBL), Problem-Based Learning (P-BL), case studies, structured and critical discussions, etc.

In addition to these new forms of content implementation, it is also necessary to develop basic skills, in particular digital. In response, there are models that allow the confluence of active and collaborative methodologies, with the use of ICT such as the TPACK model.

Research on TPACK and published articles have increased since 2003 (Chai *et al* 2013). Most papers have appeared in scientific journals such as *Australasia Journal of Educational Technology*, *Computers & Education*, *Journal of Technology*, *Teacher Education*, or *Journal of Science Education and Technology* (Cabero *et al* 2014).

The relevance of this model, in relation to the integration of ICT in teacher training and T-L processes, is clear and is confirmed by the creation of an association that is responsible for analyzing and disseminating the TPACK research conducted. The most visible reflection of this dissemination activity is the virtual community, hosted at <http://www.tpack.org/>, with presence in social networks such as Facebook and Mendeley. Jamieson-Proctor *et al* (2010) or Jang and Chen (2010) have devoted extensive literature to analyzing the TPACK model in the field of initial training and continuing teacher training.

Because of their complexity, many researchers have focused on their significance and conceptualization. Liang *et al* (2013) analyzes the characteristics of teachers and their relationship with the knowledge that make up TPACK. In this respect, Roig and Flores (2014) point out that while there is a high "content knowledge" among teachers, the same does not happen with "technological knowledge". Tsai and Chai (2013) also differentiate between novice and experienced teachers and their perception of the mastery of the elements that make up TPACK. Their research shows that while experienced teachers believe they have a better qualification of "didactic" and "conceptual" knowledge, novices raise their qualifications in "technological".

To explain the origin of the TPACK model it is necessary to go back to the original idea of Shulman (1986) called PCK. The work of this researcher and his faculty team at Michigan State University is part of the so-called "research on teacher thinking" (Fuentes, 1998:123), which focus on the teachers' planning of the contents to be taught and the activities proposed to achieve them (Goodman and Adler, 1985). Also, they analyze the contents that the teachers possess of the disciplines and that would be related to the named Specific Didactics (Marcelo 2013).

The PCK proposal emphasizes two components of the teaching-learning process that are contents (CK) and pedagogy (PK). From these, it pays special attention to how the contents of concrete subjects are organized and adapted from the pedagogy so that they arrive adequately to the students, that is, how C and P. interact.

The pedagogical paradigm in which the contribution of the PCK is placed coincides with the decline of the behaviorist models of Watson and Skinner that placed the process of teaching and learning as a reaction of students to a stimulus, neglecting their internal mental processes. This theory fails to provide consistent responses to the learning processes of the human being. It is then that researchers will be interested in the most complex cognitive processes such as thinking, problem solving, language, concept formation and information processing (Snelbecker, 1983).

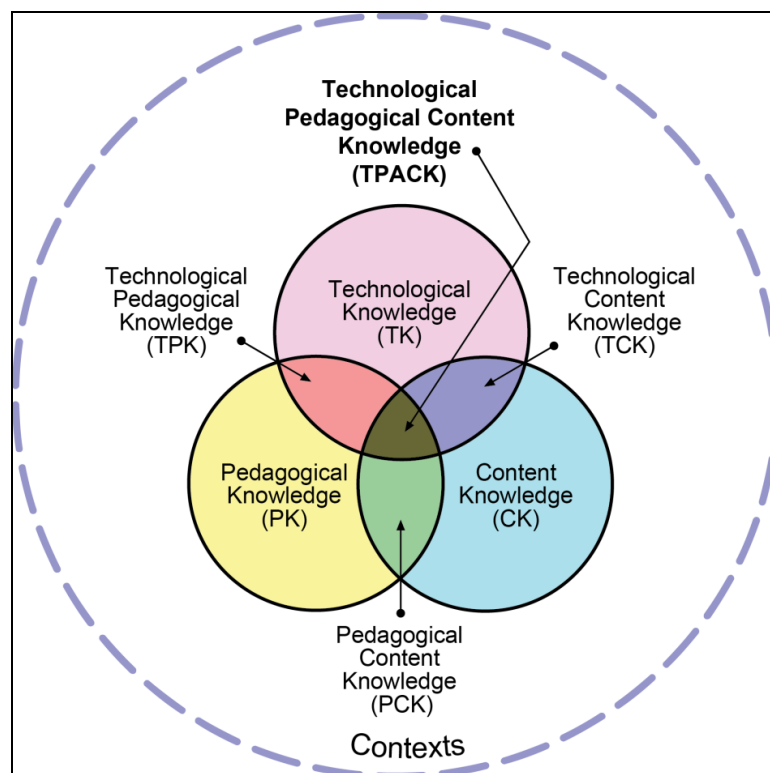


Figure 1. The TPACK model

Source: Mishra i Koehler, 2006 in: <http://tpack.org/>

From the results of the project "Knowledge Growth in a Profession: development of knowledge in teaching" and the definition of the "base knowledge" to which a teaching professional must relate, Shulman begins to arouse interest in the revaluation of studies that pay attention to how the disciplinary training and the specific didactic are united but from a new perspective (Bolívar, 1993). This new way of understanding the communion between both elements goes through a process of "reflection" of the teacher about its work of conjunction of disciplinary contents and pedagogical contents. And it is in this context that

the proposed model starts in 2006, by P. Mishra y M.J. Koehler, under the name of “Technological Pedagogical Content Knowledge” o TPACK (In Spanish Technological, Pedagogical and Content Knowledge or Discipline). The TPACK model incorporates a new variable to the idea of Shuman (PCK) which is the “technological content” (TK).

Mishra and Koehler (2006) integrate this TK into the “content of knowledge” (CK) and “pedagogical content” (PK) and emphasize the different types of knowledge that teachers need to be able to realize for the incorporation of ICTs in a correct and effective manner in order to achieve “significant effects on the learning of their students” (Cabero *et al* 2014: 22).

In this way, the TPACK model is made up of seven components (Baran *et al* 2011). Three would be the “base” knowledge: Content Knowledge (CK) o Knowledge about the content of the subject; Pedagogical Knowledge (PK); Technology Knowledge (TK). The others arise from the combination of the three “base” knowledge mentioned above: Pedagogical Content Knowledge (PCK); Technological Content Knowledge (TCK) o Knowledge of the use of technologies; Technological Pedagogical Knowledge (TPK). The Technological Pedagogical Content Knowledge (TPCK o TPACK), seventh and last component, would be the result of the conjunction of all the previous ones, that is to say, the Technological, Pedagogical and Knowled Content (Figure 1).

Consequently, the model proposes that in order for the teacher to have the training to incorporate ICT in the classroom, he / she needs not only to possess “the basic knowledge” in an isolated and independent way, but also to possess them in interaction. Only in this way will the technology be incorporated into the training process in an appropriate manner and achieve the student's intended T-L objectives.

3. PROPOSALS OF DIDACTIC INTERVENTION WITH PRIMARY GRADUATE STUDENTS

The need to train future ICT teachers has led to the development of papers and studies on how this process is carried out. There is no doubt that there is a clear need to train teachers in this technological dimension, both in the management of software and hardware as in their implementation in the classroom. The ultimate intentionality of this training is to have, in the classrooms of the different educational levels, professionals who reach their curricular objectives (concepts, skills, competencies, standards, etc.) in a simpler and adapted to the needs demanded by the Citizens of the Information and Communication Society (SIC) of the 21st century way.

The result of the courses and actions that are carried out is very diverse, depending on whether the pedagogical or technical aspects of this training have been taken into account. In most cases, more emphasis has been placed on the tool or technology to be taught without taking into account the pedagogical and classroom application of ICT. In this sense, Almerich *et al* (2011) points out this handicap in the designs of the programmed courses and also adds the little adjustment between the previous knowledge and skills with which the teaching staff starts, and the programmed contents.

From this reflection we propose a TPACK intervention for training in Geography with ICT (Barnikel and Ploetz, 2015), based on the active and participatory methodology of Problem Based Learning (PBL). This proposal has been carried out in the classroom of the 2nd year of Primary Degree Teachers, of the University of Alicante, to 240 students of this educational center.

The objectives to be developed are subdivided into two groups, on the one hand the achievement of basic knowledge of content (geographical), pedagogical and technological and on the other hand, the interrelation of all of this knowledge in a way that would achieve

significant effects on their own learning with ICT. Likewise, it is pursued the later use, by the students of Degree, of the TPACK model of T-L in the Primary classrooms.

The strategy of T-L, the PBL, has been constructed from the resolution of everyday problematic situations appearing in the mass media, the Internet or in its own geographical context.

As it is a case of project work, groups of between four and five students have been created. Each one of them has presented to the rest of companions possible problematic questions to develop. The intervention of the teacher in this phase has been limited to being a mere guide of the process and has set a clear schedule of sessions dedicated to the resolution of doubts.

A discussion group has been opened in the University's Virtual Campus where, in a joint or individual way, they raise doubts that are resolved by the rest of the classmates regardless of the group of which they are part (peer cooperation). The teacher has a role here to supervise the consultations that are carried out to take them to the classroom in the following sessions and resolve them. The project must be presented at the end of the quarter.

4. DESIGN OF ANALYSIS AND RESEARCH

The objectives of this research are mainly the achievement of CK, PK and TK, by the students of the 2nd year of Primary Degree Teachers, with special emphasis on the achievement of the interrelation of all of them through the TPACK T-L model.

4.1 Phases of research development

This study is part of descriptive (Arnal *et al* 1992) and “ex-post-facto” research, that is, the study in which the event first occurs and then the possible causes and consequences are analyzed (Cancela *et al* 2010:3).

As work tools, two questionnaires have been used and these questionnaires have been passed to the sample before and after the implementation of the training action. It is an adaptation of those proposed by Cabero *et al* (2014), which in turn are an adaptation of those used by Mishra and Koehler (2006) in their analysis on this same model. The two questionnaires are made up of 19 items with which is intended to obtain individual information on the achievement or not of the elements that make up the TPACK model individually (CK, PK, TK) and interrelated (PCK, TCK, TPK, TPACK). The structure of the same is Likert type with five response options ranging from MD = Strongly Disagree; D = Disagree; N = Neither agree nor disagree; A = Agree; TA = Totally Agree.

Another of the instruments used was direct and participant observation.

4.2 Sample of the project

The sample used in this research are 240 students of the 2nd year of Primary School Teachers of the Faculty of Education of the University of Alicante. Since it is a direct and intentional selection, due to the easy access to it, because she is the teaching researcher of these groups, a type of probabilistic-incidental sampling can be considered (Sabariego, 2004).

The group of participants is considered representative of the specific population that attends the course "Didactics of the Social Sciences: Geography" in 2nd year. Table 1 defines their sociodemographic characteristics.

Table 1. Socio-demographic data of the sample

Sex		Age		Permanence in the Faculty		Course that performs	
F	M	18-22	>22	2 years	>2	2° course	3°/4°
154	86	170	70	227	13	227	13
%	%	%	%	%	%	%	%
64,1	35,9	71,2	28,8	94,6	5,4	94,6	5,4

4.3 Instruments for collecting and processing data

As an instrument for collecting and processing the data, the statistical software SPSS (version 22) used in the Social Sciences has been chosen for its ability to work with large databases and a simple interface for most analyzes. The value of this program is its ability to perform statistical analysis and information management with data from different formats, generating graphs of distributions and descriptive statistics; complex statistical analysis that allows to discover relations of dependence and interdependence; establish classifications of subjects and variables, predict behaviors, among other advantages.

In order to evaluate the reliability of the questionnaires, the Cronbach coefficient or Cronbach's alpha, used for Likert type scale tests as in the case (Pardo y Ruiz, 2005), has been used. Likewise, correlation tests have been performed, namely Pearson Chi-square. This analysis has measured the relationship between the variables of the different elements or knowledge that the teacher must achieve to correctly implement the technology.

Another technique used was the non-parametric Kruskal-Wallis test to verify the existence of differences in the responses regarding sex, age and years in the faculty of education of the sample. In order to find the latent variables that group the questions of phase 1 and 2 of this investigation, we have analyzed the main components through the Kayes-Meyer-Olkin and Bartlett tests, which allow the definition of grouping components of variables.

4.3 Validation of the surveys used

Pearson's Chi-Square test was used to check the correlation of the answers and the adequacy assessment of the survey. It shows the high correlation between the proposed questions (p-value <1 = Sig. 0.001) which indicates the validity of the questions and the structure of the survey.

Regarding the validity of the survey, we have found the Cronbach Alpha reliability statistic with a very acceptable value of 0.989. As shown, the reliability of the survey is very high with a value close to 1 (p-value = 0.942) which gives credibility and strength to the results obtained and presented in this work.

5. RESULTS

5.1 Achieving Content Knowledge (CK)

After observing Table 2 and Figure 2, it can be observed that the highest percentage of responses on their knowledge of the content of the studied material with the TPACK model is "agree" (A) or "totally agree" (TA). These two answers represent, in all the items, more than

eighty percent of the total. In no case do the "disagree" (D) or "strongly disagree" (MD) answers represent ten percent in any of the items analyzed.

Table 2. Frequency of response of CK (Geography) items in percentages

	Item 5	Item 6	Item 7	Item 8	Item 9
MD	0,3	0,7	0,8	0,9	1,1
D	2	2,8	1,8	1,1	0,8
N	6,6	8,7	9,1	7,8	3
A	42,8	50,7	40	40,9	51,1
TA	48,3	37,1	48,3	45,3	46,7
I1: I can recognize the concepts of Social Sciences related to Geography.					
I2: The use of ICTs in the classroom of Didactics of Social Sciences: Geography has helped me to better understand the curricular contents of the area.					
I3: The group and cooperative work with ICT for the creation of didactic contents of Geography has helped me to understand geographical methodological process.					
I4: To identify aspects related to Physical and Human Geography to teach in Primary.					
I5: I consider that I am able to identify the key concepts of Geography as well as the processes that intervene in this scientific subject.					

5.2 Achievement of Pedagogical Knowledge (PK)

The analysis of Table 3 and Figure 2 shows that the highest percentage of responses on pedagogy (including classroom methodology and management) is "agreed" (A) or "fully agreed" (TA). As with CK, in the KP, these two answers represent, in all the items, more than eighty percent of the total. In no case do the "disagree" (D) or "strongly disagree" (MD) answers represent ten percent in any of the items analyzed.

Table 3. Frequency of response of PK items in percentages

	Item 10	Item 11	Item 12	Item 13	Item 14
MD	1,1	0,3	0,2	0,9	0
D	0,8	0,8	0,9	2,3	0,3
N	3	2,7	4	7,6	4,6
A	51,1	49,7	45	43,8	44,8
TA	46,7	46,5	49,9	45,4	50,3
I10: The use of collaborative didactic proposals and ICT help help the acquisition of geographic contents.					
I11: I believe that ICTs allow the presentation of active methodological strategies in the Social Sciences: Geography classroom as a teacher.					
I12: I consider that the correct inclusion of ICT for content design on Geography has an impact on my training as a teacher.					
I13: I am able to design active and cooperative classroom strategies with technology for the teaching of Geography.					
I14: I know how to implement active methodologies with technology to teach Geography.					

5.3 Achievement of Technological Knowledge (TK)

As in the other two previous components (CK, PK) the analysis of Table 4 and Figure 2 shows the highest percentage of responses on TK perception in the "agree" (A) or "totally Agreement" (TA). As with CK and PK, these answers represent, in all the items, more than eighty percent of the total. And, just as the "disagree" (D) or "strongly disagree" (MD) answers represent ten percent in none of the items analyzed.

Table 4. Frequency of response of TK items in percentages

	Item 15	Item 16	Item 17	Item 18	Item 19
MD	0,6	0,3	0,2	0,9	0,2
D	1	0,8	0,9	1,4	0,8
N	2,8	1,9	4	4,6	1,4
A	36,3	47,5	45	43,8	47,8
TA	50,5	49,3	49,5	49,3	49,8
I15: The use of ICT for the creation of didactic contents has helped me to understand the curricular contents of Geography.					
I16: The use of ICT for the creation of materials has facilitated my understanding of the different procedures of geographic science.					
I17: Learning to use ICT improves my geographical skills as a student and as a future teacher of Geography.					
I18: ICTs allow the presentation of active methodological strategies in the classroom as a teacher of Geography.					
I19: I believe that the correct inclusion of ICT for the design of content on Geography has an impact on my training as a teacher.					

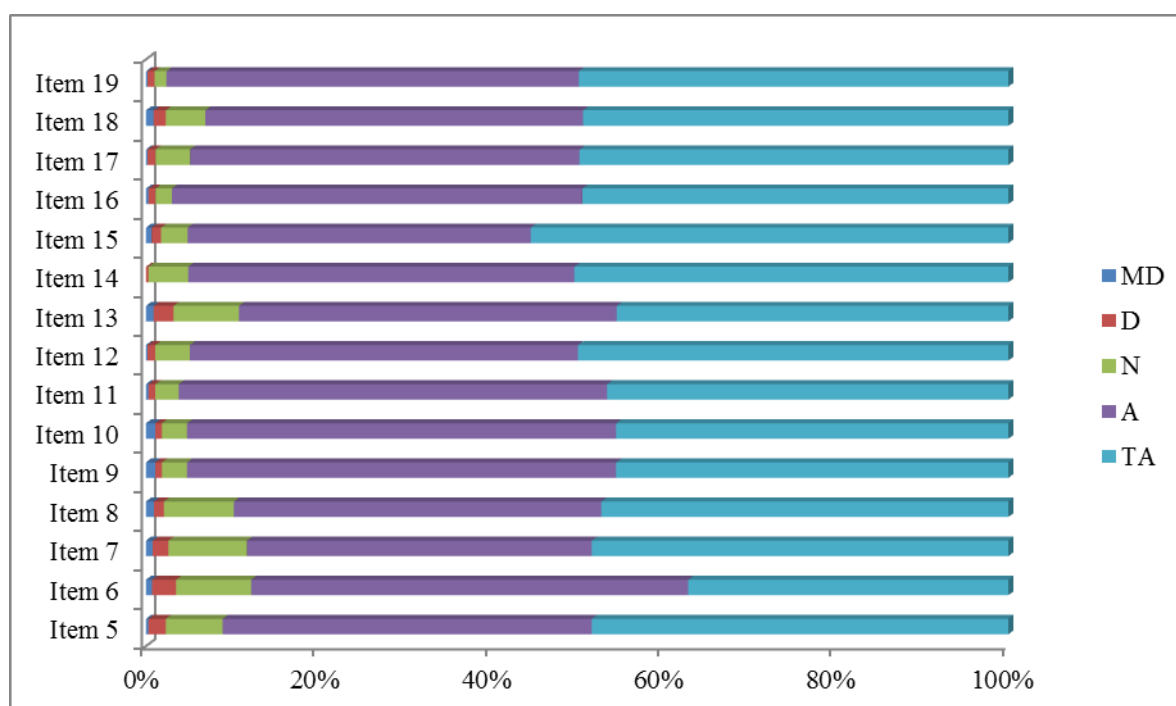


Figure 2. Results in the acquisition of knowledge TK, TP, PK of the analyzed sample

6. DISCUSSION AND CONCLUSION

There are many studies on the perception and technological training of future teachers (Roblizo and Cózar, 2015, Ortega y Gómez, 2015). In them, it's remarked that there is a need to implement methodological strategies that achieve the acquisition of ICT knowledge from a dimension not only manipulative but also pedagogical. In this sense, the scientific production that analyzes the possibilities offered by technologies for the acquisition of geographic competences is limited. Although the adaptation of the technologies to the processes of learning of the geographic space is allowed (Mentz, 2010, Ortega, Gómez y Moreno, 2016) there are few articles that take into account ICT for the acquisition of disciplinary knowledge (CK) among teachers.

In conclusion, after the analysis made it can be said that the work in the didactic classroom of Geography with the TPACK model does develop the CK and the capacity of its acquisition, also allowing the training of the sample in pedagogical knowledge (PK) and technological (TK).

The essential part of the study carried out is that from the acquisition of the basic components of the model, the positive predisposition to the use of ICTs is observed, from a previous pedagogical design and not as a simple substitute tool for the chalkboard or the traditional book. This new characteristic of the sample begins to be observed in the second phase of analysis in which the research is at this moment. Thus, it has been observed that the items presented in the survey on the interrelated knowledge of the basic components (PCK, TPK, TCK) show a high frequency of "agree" or "totally agree" responses indicating that the Model developed can be a new and functional form of incorporation of the TIC in the classrooms of Degree and, consequently, of Primary.

For all this, the classroom intervention carried out shows solid, quantitative and qualitative data, which emphasize the need to use T-L models in which a correct inclusion of ICT is carried out through an adequate training in digital skills (TK) without abandoning the acquisition of disciplinary content (CK) and training in active and cooperative (PK) methodologies. The results of the research indicate conclusively the need of the present society and the EHEA (Bolonia, 1999) to provide future teachers with a complete and non-dissociated training in pedagogical, technological and disciplinary knowledge (TPACK).

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